REMARKS

The Office Action has rejected Claims 1, 5, 6, 8-10, 13-15, 18, 19, 22 and 23 under 35 U.S.C. §103 as defining subject matter which is allegedly rendered obvious by the teachings of U.S. Patent No. 6,572,775 to Heikkila et al. ("Heikkila et al.") as allegedly evidenced by the teachings in U.S. Patent No. 5,348,871 to Scott et al. ("Scott et al.") in view of the teachings of U.S. Patent No. 5,988,177 to Catani et al. ("Catani et al.") and in view of the teachings of U.S. Patent No. 5,391,299 to Masuda et al. ("Masuda et al."). Claims 1 and 10-12 are rejected under 35 U.S.C. §103 as defining subject matter which is allegedly rendered obvious by the teachings in Heikkila et al. as allegedly evidenced by Scott et al. in view of Catani et al. and Masuda et al. and further in view of the teachings of U.S. Patent No. 6,129,788 to Liaw et al. ("Liaw et al."). Finally, Claims 1, 15, 16, 24 and 25 are rejected under 35 U.S.C. §103(a) as defining subject matter which is allegedly rendered obvious by the teachings in Heikkila et al. as allegedly evidenced by Scott et al. in view of Catani et al. and Masuda et al. and further in view of the teachings of U.S. Patent No. 6,436,678 to Antrim et al. ("Antrim et al.").

At the outset before addressing the issues raised in the Office Action, it is to be noted that applicants have cancelled Claims 1-25 without prejudice. Applicants have not abandoned the deleted subject matter therein and reserve the right to file a continuation application directed thereto.

Claims 26-38 have been added to the application. The subject matter therein is supported by the underlying disclosure. For example, support for Claim 26 is found in the instant specification. Attention is directed to original Claim 16; Page 9, Line 32 to Page 10, Line 23; Page 7, Lines 16-24; Page 6, Lines 2-29; Page 12, Line 26 to Page 13, Line 2; Page 2, Lines 1-5, original Claim 15; and Examples 10, 12 and 13. Support for Claim 27 is found in original

Claim 16; Page 9, Line 32 to Page 10, Line 23; Page 7, Lines 16-24; Page 6, Lines 2-29; Page 12, Line 26 to Page 13, Line 2; Page 2, Lines 1-5, originally filed Claim 15 and Examples 10, 12 and 13. Original Claim 8 supports the subject matter in Claim 28, while original Claim 9 supports the subject matter in Claim 29. Claim 30 incorporates the subject matter of original Claim 6, while Claim 31 incorporates the subject matter of original Claim 13. Claim 32 incorporates the subject matter of original Claim 14. Support for Claims 33-36 is found on Page 7, Lines 16-24 of the instant specification, while support for Claims 37 and 38 is found on Page 11, Lines 5-31 of the instant specification.

No new matter is added to the application.

The present invention is directed to a process for producing pure maltitol from a feed solution having a maltose content of 70 to 90 weight %, a maltotriose content of less than 10 weight % and a glucose content of less than 10 weight % on a dry solids basis. The process is described in Claims 26 and 27 and claims dependent thereon. The process of Claim 26 starts with a feed solution which contains maltose (a dimer), maltotriose (a trimer) and glucose (a monomer). In the first step, the feed solution is subjected to the chromatographic separation using a cation exchange resin having a degree of crosslinking of 2-4.5%. This resin mainly removes the maltotriose trimer from the feed solution. The resulting maltose fraction further comprises glucose and a small amount of residual maltotriose. This fraction is then hydrogenated, as for instance, taught in Example 10, which converts maltose to maltitol, glucose to sorbitol and maltotriose to maltotritol. Maltitol is then crystallized from this mixture as taught in originally filed Claims 15 and 16 together with Example 13. Finally, the mother liquor remaining from the crystallization is subjected to a second chromatographic separation step using

a cation exchange resin having a degree of crosslinking of from 5-8% which tends to remove monomeric components from the feed, e.g., sorbitol.

Claim 27 is closely related to Claim 26 differing only in that the first chromatographic separation is carried out using the cation exchange resin having a relatively high degree of crosslinking, whereas the second separation is carried out using the cation exchange resin having a relatively low degree of crosslinking.

In an embodiment, if the maltotriose content of initial maltose feed solution is high, then it is advantageous firstly to remove a significant proportion of this maltotriose by using a cation exchange resin having a (relatively low) degree of crosslinking of 2-4.5%, as in Claim 26. The purified product is then hydrogenated to obtain a maltitol solution which has a relatively low content of maltotritol. After the hydrogenation and crystallization, sorbitol in the mother liquor formed by the hydrogenation of glucose is removed by using a cation exchange resin having a (relatively high) degree of crosslinking of 5-8%.

In an embodiment, if the glucose content of the initial maltose feed solution is high, then it is advantageous firstly to remove a significant proportion of this glucose by using a cation exchange resin having a (relatively high)degree of crosslinking of 5-8%, as recited in Claim 27. The purified product is then hydrogenated to obtain a maltitol solution which has a relatively low content of sorbitol. After the hydrogenation and crystallization, maltotritol in the mother liquor formed by hydrogenation of maltotriose is removed by using a cation exchange resin having a (relatively low) degree of crosslinking of 2-4.5%.

None of the prior art on file is even remotely concerned with such processes for producing maltitol from a maltose feed solution.

Pursuant to the rejection of claims under 35 U.S.C. §103(a), the Office Action cites Heikkila et al., Scott et al., Catani et al. and Masuda et al. According to the Office Action,

> Heikkila et al. discloses a method for fractionating a solution into two or more collected fractions by a chromatographic simulated moving bed process…Heikkila et al. discloses Finex CS 13 GC, a polystyrene matrix corsslinked with divinylbenzene (DVB)…Heikkila et al. discloses the use of Finex columns crosslinked with 5.5% DVB to separate sucrose, a disaccharide from trisaccharides and monosaccharides…Heikkila et al. further discloses the use of Purolite PCR 651 with 5.5% DVB for purification of sucrose without any other saccharides. Heikkila et al. discloses molasses, starch hydrolysates, and wood hydrolysates as suitable feed solution…As evidenced by Scott et al., wood hydrolysate contains the disaccharide cellobiose…Heikkila et al. discloses the separation of monosaccharides, disaccharides and trisaccharides, specifically glucose, fructose, sorbitol and sucrose…

However, Heikkila et al. do not disclose the separation of a mixture containing three sugar alcohols, maltitol, sorbitol and maltotriol. A review of Heikkila et al. reveals that none of the separations described therein relate to the separation of sugar alcohols from each other. Although Heikkila et al. disclose the separation of glucose, fructose, sorbitol and sucrose, it does not teach, disclose or suggest the separation of maltitol from the three sugar alcohols. Further, Heikkila et al. do not teach, disclose or suggest the crystallization of maltitol to separate it from a mixture comprising maltitol, sorbitol and maltotriol.

But more importantly, there is no teaching or suggestion in Heikkila et al. that involves the strategy of producing pure maltitol and/or separating maltitol from maltotriose and glucose through the strategy, as recited in the claims--let alone, the overall scheme of using a cation exchange resin with a degree of crosslinking of 2 to 4.5% to remove maltotriose, hydrogenating a maltose-fraction containing 90-96 weight % of maltose with a yield of at least 85% to form a mixture comprising maltitol, sorbitol and maltotriose, crystallizing maltitol to separate it from the other sugar alcohols, subjecting the mother liquor to a second cation exchange column with crosslinking of 5 to 8% to remove sorbitol and isolate maltitol, as recited

in Claim 26. Further, Heikkila et al. do not teach the overall scheme outlined in Claim 27, namely subjecting the feed referred to hereinabove to chromatography using a cation exchange resin with a degree of crosslinking of 5 to 8% to separate glucose from a solution of maltose, maltotriose and glucose, hydrogenating a maltose fraction containing 90-96 weight % of maltose with a maltose yield of 85 weight % or higher, to form maltitol, maltotriol and sorbitol, crystallizing maltitol from the mixture, subjecting the mother liquor to chromatography using a cation exchange resin of 2 to 4.5% to remove maltitriol and and obtain a maltitol fraction.

The secondary references do not overcome the deficiencies of Heikkila et al. Masuda et al., according to the Office Action disclose a moving bed fractionating method to separate maltose, a dissacharide from starch and purify maltose by crystallization. Catani et al. disclose the use of an anionic exchange resin, such as the sodium salt of an anionic exchange resin with a crosslinking of 4 to 6% to separate out glucose from a feed solution containing glucose, sucrose and higher fractions. At best, the combination would suggest a step in which maltose is crystallized, not maltitol as claimed and utilizing an anionic exchange resin to separate maltose, glucose, sucrose and not to separate maltitol from sugar alcohols, as claimed.

Thus, even when the cited references are combined there is no teaching or suggestion of using either a cation exchange resin with either a degree of crosslinking of 2 to 4.5% to remove maltitriol and to isolate maltitol from a feed solution of maltitol, maltotritol and sorbitol, as recited in Claim 27 or to use a cation exchange resin with a crosslinking of 5-8% to remove sorbitol from a mixture comprising maltitol, sorbitol and maltotriol and obtain maltitol therefrom, as recited in Claim 26. Furthermore, none of the references taken alone or in combination teach, disclose or suggest the crystallization of maltitol. Moreover, none of the publications taken together teach, disclose or suggest the overall scheme outlined in Claim 26 or

Claim 27 to produce maltitol from a feed having a maltose, maltotriose, and glucose. Although the art may contain one of the steps, there is no suggestion from the combination of the art of the overall scheme recited in Claims 26 or 27. As indicated hereinabove, none of the cited publications teach, disclose or suggest the steps of preparing maltitol utilizing the steps specifically enumerated in Claims 26 and 27 or claims dependent thereon. Further, there is no teaching or suggestion in any of these publications that the process would require a separation of sugar alcohols utilizing a cation exchange resin, with a degree of crosslinking of 5 to 8% to separate sugar alcohols, as in Claim 26 and claims dependent thereon or a cation exchange resin with a degree of crosslinking of 2 to 4.5% to separate maltitol from sugar alcohols, as in Claim 27 and claims dependent thereon. And there is no teaching or suggestion of all of these steps in a process to produce purified maltitol.

Thus, for the reasons presented herein, this rejection under 35 U.S.C. §103(a) is overcome, withdrawal thereof is respectfully requested.

Pursuant to the second rejection under 35 U.S.C. §103, the Office Action cites Heikkila et al., Scott et al., Catani et al., Masuda et al. and Liaw et al.

The Office Action reiterates its comments respecting Heikkila et al., Scott et al., Catani et al. and Masuda et al. It cites Liaw et al. for its teaching of using enzymes, such as α–amylose to treat starch and for saccharification using β-amylase and transglucosidase, such as pullulanase.

But, Liaw et al. do not address the deficiencies as described hereinabove in Claims 26 and 27 as it is being cited for the teaching regarding the use of enzymes. Thus, applicants reiterate the comments regarding the first rejection, as the arguments hereinabove are also applicable to address this rejection, the contents of which are incorporated by reference.

More specifically, there is no teaching or suggestion in any of the publications, alone or in combination that a cation exchange resin with either 2 to 4.5% degree of crosslinking or 5-8% degree of crosslinking would separate maltitol from a mixture of sugar alcohols. Furthermore, there is no teaching or suggestion in the cited references taken together of crystallizing maltitol from a mixture of sugar alcohols. None of the references teach, disclose or suggest such a step. In short, neither Heikkila et al., Scott et al., Catani et al., Masuda et al. nor Liaw et al., either alone or in combination, teach, disclose or suggest the overall schemes recited in Claims 26 and 27 et seq. Thus, for the reasons provided, this rejection is overcome, withdrawal thereof is respectfully requested.

Pursuant to the third rejection under 35 U.S.C. §103, the Office Action cites Heikkila et al., Scott et al., Catani et al., Masuda et al. and Antrim et al.

The Office Action repeats its comments regarding the teachings of Heikkila et al., Scott et al., Catani et al. and Masuda et al. The Office Action cites Antrim et al. for its teaching of utilizing β-amylase enzyme for producing maltose from starch. However, the Office Action cites the following passage from Column 1, Lines 30-40.

> Similarly, in the preparation of maltitol, it is commercially desirable to provide maltose in a substantially pure form, so that sorbitol and higher molecular weight hydrogenated sugars such as maltotritol are not formed upon hydrogenation of the maltose.

Applicants reiterate the arguments hereinabove with respect to the teachings of Heikkila et al., Scott et al., Catani et al. and Masuda et al., the contents of which are incorporated by reference. Moreover, inasmuch as Antrim et al. do not overcome the deficiencies, the arguments made hereinabove are also applicable here. None of the references, alone or in combination teach, disclose or suggest a step of recrystallizing maltitol from sugar alcohol. In addition, there is no teaching or suggestion in the publications taken together of using a cation

exchange resin of either 2-4.5% or 5-8% to separate maltitol from sugar alcohols. Further, the combination of the publications fails to teach, disclose or suggest the overall scheme recited in Claims 26 and 27 and claims dependent thereon. It is respectfully submitted that the combination of these publications with Antrim et al. not only do not teach or disclose or describe the process of the present invention but also the combination of these publications with Antrim et al. teach away from the claimed process.

As indicated in the above quotation in Antrim et al., Antrim et al. suggest that in the formation of maltitol, it is desirable to provide maltose in substantially pure form so that sorbitol and higher molecular weight hydrogenated sugars such as maltitotriol are not formed upon hydrogenation of the maltose. Contrary to the allegations of the Office Action, the combination of Heikkila et al., Scott et al., Catani et al., Masuda et al. and Antrim et al. would suggest a process of making maltitol by avoiding the formation of a mixture comprising maltitol, sorbitol and higher molecular weight hydrogenated sugars, such as maltitotriol. However, as recited in the claims, one of the steps in the present process as recited in Claims 26 or 27 and claims dependent thereon is to hydrogenate a maltose fraction to form a mixture of maltitol, sorbitol and maltotriol and then separating the maltitol therefrom. Thus, the combination of publications teach away from the present process.

Consequently, this rejection under 35 U.S.C. §103 is obviated, withdrawal thereof is respectfully requested.

Thus, in view of the Amendments to the claims and the remarks, hereinabove, it is respectfully submitted that the present case is in condition for allowance, which action is earnestly solicited.

Respectfully submitted,

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